REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	2 Jun 99	Master's Thesis 6 Aug 99 - 2 Jun 99

4. TITLE AND SUBTITLE

Just-in-Time Effects on Peacetime Efficiency and Wartime Readiness

5. FUNDING NUMBERS

6. AUTHOR(S)

MAJ William B. Miracle

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
1 Reynolds Ave., Bldg. 111, Rm. 123
Ft. Leavenworth, KS 66027-1352

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/ MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING

11. SUPPLEMENTARY NOTES

20001115 092

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

A

13. ABSTRACT (Maximum 200 words)

This study assesses the suitability of just-in-time (JIT) logistics in support of a major theater war. It defines just-in-time logistics and analyzes the reasons the Army adopted just-in-time principles. The study also shows the peacetime efficiencies of just-in-time logistics and how they may be applied to a major theater war.

This is a study of JIT practices within the U.S. Army. It reviews the recent history of logistics support to the U.S. Army in the last century and examines the reasons for the adoption of just-in-time logistics. In the examination it defines just-in-time logistics and the Army version of it, Velocity Management. This study shows the criteria the Army used in finding a new logistics solution, the civilian examples of just-in-time success, and the goals set out by the CSA to hasten the implementation of Velocity Management.

In a downsized Army in an interwar period resources are scarce, making efficient and reliable systems necessary. Velocity Management was adopted to increase efficiency in the logistic system while reducing manpower and financial requirements.

While Velocity Management is proving to be an efficient peacetime solution for logistics, it is yet untested in the environment of combat. The numerous variables that make it so efficient are endangered in the environment of conflict. This study examines some of the predicted logistics requirements of a major theater war and assesses the ability of Velocity Management to adequately provide the necessary support.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Just-in-time logistics, major theater war, just-in-time principles, velocity management, logistics requirements	72
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-380-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

JUST-IN-TIME EFFECTS ON PEACETIME EFFICIENCY AND WARTIME READINESS

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

WILLIAM B. MIRACLE, MAJ, USA
B.S., United States Military Academy, West Point, New York, 1985

Fort Leavenworth, Kansas
2000

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

Name of Candidate: Major William B. Miracle

Thesis Title: Just-in-Time Effects on Peacetime Efficiency and Wartime Readiness

Approved by:

________________________________, Thesis Committee Chairman
LTC Willis F. Jackson, Jr., M.P.A.

________________________________, Member
LTC Lewis L. O'Hern, M.P.A.

________________________________, Member, Consulting Faculty
James B. Martin, Ph.D.

Accepted this 2d day of June 2000 by:

________________________________, Director, Graduate Degree Programs
Philip J. Brookes, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

JUST-IN-TIME EFFECTS ON PEACETIME EFFICIENCY AND WARTIME READINESS, by MAJ William B. Miracle, USA, 63 pages.

This study assesses the suitability of just-in-time (JIT) logistics in support of a major theater war. It defines just-in-time logistics and analyzes the reasons the Army adopted just-in-time principles. The study also shows the peacetime efficiencies of just-in-time logistics and how they may be applied to a major theater war.

This is a study of JIT practices within the U.S. Army. It reviews the recent history of logistics support to the U.S. Army in the last century and examines the reasons for the adoption of just-in-time logistics. In the examination it defines just-in-time logistics and the Army version of it, Velocity Management. This study shows the criteria the Army used in finding a new logistics solution, the civilian examples of just-in-time success, and the goals set out by the CSA to hasten the implementation of velocity management.

In a downsized Army in an interwar period resources are scarce, making efficient and reliable systems necessary. Velocity management was adopted to increase efficiency in the logistic system while reducing manpower and financial requirements.

While velocity management is proving to be an efficient peacetime solution for logistics, it is yet untested in the environment of combat. The numerous variables that make it so efficient are endangered in the environment of conflict. This study examines some of the predicted logistics requirements of a major theater war and assesses the ability of velocity management to adequately provide the necessary support.

ACKNOWLEDGMENTS

In any endeavor such as this, there are many who provide invaluable assistance behind the scenes. I could not have completed this study without the leadership of LTC Willis F. Jackson, the guidance of LTC Larkin O'Hern, and the technical expertise and wisdom of Dr. James B. Martin. Their devotion of time, patience, and professional guidance were essential to this undertaking.

The most difficult part of this project was getting started on a subject that I have limited experience with. The input and experience of classmates MAJ Tim Orner and MAJ Mike Flanigan were crucial to getting me started on this study.

Finally, and most importantly, I cannot give enough credit to my family for their support and constant motivation in my efforts. Chris's constant support and assistance were crucial to my completion of this project. The patience and understanding of Anthony, Joli, and William was inspirational while I spent many long hours working on this project.

TABLE OF CONTENTS

ABBREVIATIONS

AAR	After-Action Review
AMC	Army Materiel Command
ARNG	Army National Guard
ARNG PIT	Army National Guard Process Improvement Team
ASL	Authorized Stockage List
CASCOM	Combined Arms Support Command
COMMZ	Communications Zone
COSCOM	Corps Support Command
CSS	Combat Service Support
DISCOM	Division Support Command
DLA	Defense Logistics Agency
DOA	Department of the Army
DOD	Department of Defense
DO PIT	Deployed Operations Process Improvement Team
EIP	Economical Inventory Policy
FIN PIT	Financial Process Improvement Team
FLE	Forward Logistics Element
FMC	Fully Mission Capable
ITV	In-Transit Visibility
JIT	Just in Time
LPT	Logistics Preparation of the Theater

LSE	Logistics Support Element
MMC	Materiel Management Center
MTW	Major Theater War
NMC	Non-Mission Capable
NMS	National Military Strategy
NSS	National Security Strategy
O & S PIT	Order and Ship Process Improvement Team
OOTW	Operations Other Than War
OPTEMPO	Operational Tempo
ORF	Operational Readiness Float
OST	Order Ship Time
PLL	Prescribed Load List
RC PIT	Repair Cycle Process Improvement Team
SIT	Site Improvement Team
SD PIT	Stockage Determination Process Improvement Team
TAV	Total Asset Visibility
TRANS PIT	Transportation Process Improvement Team
USAR	United States Army Reserve
USAR PIT	United States Army Reserve Process Improvement Team
USAREUR	United States Army Europe
VG	Velocity Group
VM	Velocity Management

CHAPTER 1

INTRODUCTION

Overview

The U.S. Army experienced the most extreme drawdown in its history during the last decade of the twentieth century. With this drawdown came some severe cuts in the defense budget. The Army enters the next century in an environment of constrained resources. With the needs for force modernization, personnel initiatives, and quality of life improvements the Army seeks efficiencies in other areas, most notably the logistics arena. Just-in-Time (JIT) principles, effective methods for maximizing efficiency in the corporate world, have been adopted as Army solutions within the logistics system. While JIT has produced the expected efficiencies, it is still unproven in a combat environment.

Background

The background for this topic involves the history of logistics support for past U.S. Army operations. Since the Revolutionary War, the United States has dealt with the problems of supplying war. The logistics problems during the Civil War, World War I, World War II, Korea, Vietnam, and the Gulf War have all been analyzed and studied. The Army's great commanders have recognized the need for a logistics structure that is robust enough to support their plans. History offers numerous examples of commanders who achieved success with good logistics support. It also offers many examples where command objectives were not met due to logistics failure. The effects of the industrial revolution have been internalized by the Army, and now the information age presents new challenges, and new solutions, for this timeless problem. As the Army moves into

the future as a pre-eminent world power it must insure it is postured for success. This paper will address how JIT positions U.S. Army logistics for military operations.

Today's smaller Army, with the resultant higher operational tempo (OPTEMPO), has a magnified need for increased efficiencies. The reduced Department of Defense (DOD) budget, a post-Cold War by-product, causes competing demands for limited financial resources. A comparison to and an analysis of the civilian sector has identified the financial success of corporations that have adopted JIT principles. This research will use a civilian model of JIT employment to compare with the Army JIT model, in order to recognize similarities, possible weaknesses, and potential strengths.

Unit movement officers and logisticians during Operations Desert Shield and Desert Storm were made keenly aware of the logistics stockpiling done at the unit level to ensure their units were adequately resourced to conduct operations upon arrival in theater. While the logistics community can rightfully take pride in the support provided for combat operations in Southwest Asia, the environment has changed considerably since then. Reduced prescribed load lists (PLLs), authorized stockage levels (ASLs), and drawdown effects on the military budget have all affected logistics in the military. Commanders and executive officers deal daily with logistics challenges that test their units' ability to conduct the mission. Those with a good understanding of the logistics structure, even if relatively rudimentary, have a big advantage in the conduct of their duties. By understanding PLL, ASL, resupply, requisition, and tracking procedures, combat arms commanders are able to keep their units adequately resourced for the increased OPTEMPO and short notice deployments common today in the United States Army.

As JIT spread Army-wide, the net effect has been reduced order-ship times (OST), improved total asset visibility (TAV) during transit, and reduced down time for major fleets, as well as the desired cost efficiencies. The after-action reviews (AARs) conducted by logisticians during every stage of this transition have apparently been very productive. However, unexpected or short notice contingencies have revealed some possible flaws in this system. Units deploying into theater recently (Bosnia and Albania) saw immediate changes in the reliable, timely logistics support to which they were accustomed. This naturally raises the question of whether JIT is a peacetime solution or a full-time solution that is just not well tested in a rigorous deployment-type scenario. As a combat arms officer with some knowledge of, experience with, the logistics system, the researcher is compelled to analyze the adequacy of this "new way of doing business" as it relates to units' abilities to accomplish wartime missions.

Scope

The scope of this topic is DOD-wide, but in this paper it will be limited to its effects only on the U.S. Army. At the national level the Army is driven by the national security strategy (NSS) to pursue three objectives: enhancing security, bolstering economic prosperity, and promoting democracy abroad. The U.S. military has some important responsibilities, as laid out in the NSS and national military strategy (NMS), to have strategies (contingency plans) to deter and defeat large-scale, cross-border aggression in two distant theaters in overlapping time frames (hereafter referred to as the "two MTW scenario"). From this point the scope of this study was narrowed to include just the U.S. Army.

The next step in focusing the scope was determining a time frame for analysis. For historical analysis, only U.S. Army operations of the twentieth century will be the focus. This must be done for various reasons, the two most pressing being the relevance offered by relatively recent operations and the need to reduce the research to a manageable level to allow a more thorough analysis. The research had to focus on a specific time frame for the application of the thesis. Any time frame beyond 2005 would involve too much speculation about projected missions, force structure changes, and logistics requirements. To reduce this speculation and the number of assumptions necessary for analysis, the research will focus on fiscal year 2000 to the fiscal year 2005 time frame for application of this thesis.

The topic will be approached from the perspective of a combat arms officer seeking to gain confidence in a new logistics system. While the combat service support (CSS) community has generated much of the discussion on this topic, the combat arms units have grudgingly accepted it, without question. This is due to the relative invisibility of JIT to the peacetime commander. At the user level, in peacetime, the flow of logistics looks relatively unchanged despite the change to JIT. With the infrastructure, complete with civilian and corporate interface at various levels, in place to support logistics operations, the commander knows that he gets what he needs and has little knowledge of, or interest in, how the system has changed. However, the tools he uses on a daily basis have direct input into, and a corresponding impact on, JIT.

Thesis

Can JIT- principled logistics support a major theater war (MTW)?

Subordinate Questions

1. Has logistics support been adequate for previous U.S. Army operations?
2. What exactly is JIT?
3. What are the reasons for changing to JIT?
4. How has the Army implemented JIT?
5. Is JIT an interwar period phenomenon?
6. Will JIT support an MTW?

Limitations

Changes in anticipated logistics requirements for future MTWs could present difficulties in this research. These projections could change based on force structure, systems and anticipated threat. For example, since research began on this topic many major systems approved for integration into the force structure have been dropped and the medium weight brigade has been identified as a supplement to the current force structure. This problem has been minimized as much as possible by choosing the fiscal year 2000 to the fiscal year 2005 as the research time frame. Combined Arms Support Command (CASCOM) web sites and information will be utilized for the most recent data, based on war games and simulations.

Finding Army-specific numbers for a single MTW could also be problematic as scenarios often combine data for the joint force and sometimes combine data for the two MTW scenario. Whenever information requires the extrapolation of predicted Army

logistics data from a joint force roll-up it will be clearly identified, with an explanation of how the Army data was derived from joint force numbers.

Historical Army data may be used, in conjunction with future projections, to best determine Army projections. Whenever information is derived from historical data, it will be identified, with an explanation of why it is being used.

The lack of necessary information will limit this study, in the absence of some of this information, assumptions had to made. In conducting this research a few initial assumptions had to be made. The first assumption made is in reference to the accuracy of the predicted logistics requirements for future MTWs. This assessment will only be as accurate as this predictive information.

The second assumption is that JIT principles will continue to be applied as they currently are within the U.S. Army. If JIT is only a peacetime solution to efficiency problems then the research will address that. If there is a variation of peacetime JIT to that used in a war, the differences, and how they were derived, will be addressed. Of course, any projected changes or evolutions of current JIT implementation will be considered during the final analysis of this study.

The third assumption, based on the scope and timeframe identified earlier, is that the U.S. Army will fight with its current force structure. The force structure is changing as this research continues, validating the necessity of this assumption. To avoid the difficulty of keeping up with each modification, the current structure will be used.

Delimitations

While the scope of this study was intentionally focused on the U.S. Army between the fiscal year 2000 to the fiscal year 2005, it may be applicable for the other armed services and other DOD agencies. If there are no significant changes to predicted logistics requirements in other timeframes, it may be used beyond the fiscal year 2005. Commanders at all levels, battalion through corps, should find this study applicable for logistics at their level, in terms of how they can impact the system.

Significance of the Study

History clearly shows the importance of logistics to the combat commander. At its most basic, JIT means getting the right item to the right place at the right time. In peacetime each of these three components (need, location, and time) are fairly predictable, making JIT effective. In wartime, however, the friction that Clausewitz refers to can affect the predictability of items needed, the location (or access to the location) where it is needed, and the time factor. Additionally, the effects of an uncooperative enemy cannot be discounted. This is the crux of the importance of this thesis. The Army's peacetime systems must be transferable to the wartime environment. "We must accept the fact that even the most carefully conceived logistical contingency plans fail to prepare us for the chaotic environment that can occur in battle" (Heiser 1991, 151).

As the Army moves into the Force XXI environment the combat commanders need to be able to justify their trust in a revised logistics system that is yet untested. This topic is extremely important as logistics takes on an increasingly important role in military operations due to the many ongoing operations, the ever-increasing number of

contingency missions, and the continued limitations on logistics resources. The commanders who understand JIT can use it to best support the mission by correctly utilizing the tools at their level. Without this understanding of JIT, its advantages and constraints, commanders could find themselves lacking essential support in an MTW.

This study is not the first to question the adequacy of JIT principles in Army logistics, as there are many logisticians who have given the concept a fair amount of professional scrutiny. This thesis will provide an analysis of JIT capabilities measured against the requirements of an MTW, in doing so, will add substantially to the body of knowledge on current Army logistics procedures. This thesis will also provide a look at the problem from a combat arms perspective, thereby making it more useful for the combat arms commander who will have to rely on JIT-based support to accomplish his wartime mission.

CHAPTER 2

REVIEW OF LITERATURE

There are many publications and resources closely related to this topic. Some of these publications will provide the necessary background to illustrate the necessity of adequate logistics in war. These books cover military operations in this century through World War II, Korea, and Vietnam and up to Operations Desert Shield and Desert Storm. These historical publications covering twentieth century U.S. Army operations are most relevant and will be the basis for much of the background information.

The Center for Military History has many publications that offer U.S. military experiences in past operations; these will be used as well. Whenever possible, the research will rely on literature written by logisticians who were involved in the many operations of the U.S. This is due to their first-hand involvement in logistics and their professional expertise in assessing the logistics situation for a given period or operation.

There are also a number of publications and articles about JIT management principles, which outline its components and provide examples of its efficiency, these include *Well Made in America; Lessons from Harley-Davidson on Being the Best,* and *Japanese Manufacturing Techniques*. These publications will show the relevance of JIT principles. Once the efficiencies of JIT principles are explained, it will be easy to understand why the principles have spread through industry so quickly and were readily adopted by a budget-cutting DOD.

There are a large number of articles, civilian and military, which discuss the advantages and disadvantages of JIT, based on personal experiences and professional speculation. Some periodicals, such as *Army Logistician*, offer many articles from

logisticians in the field who are out there implementing current Army logistics policies everyday. These sources will prove invaluable to the research. Many of these authors have reached conclusions on the applicability of JIT principles in Army or DOD logistics.

Some of these articles describe the differing environments between the corporate world and the military, thus dismissing JIT as unsuitable. Other articles describe JIT as a panacea that has solved most of the logistics efficiency problems in the military. These differing conclusions will only be considered when adequate support is provided for the position. In some of these articles, opinions get in the way of the facts, so the value of the article is reduced.

Graduate theses, individual study projects, and CASCOM studies are also invaluable to the body of knowledge on this subject. Many of these will be used for background during this study. CASCOM studies contain the most relevant and recent information about predicted logistics requirements and will be used extensively for this analysis.

CHAPTER 3

RESEARCH METHODOLOGY

As explained previously, the purpose of this paper is to determine if JIT-principled logistics can support an MTW. To answer this question there must first be a full definition of JIT as it relates to the U.S. Army. The research will then compare the U.S. Army JIT system to one used in a civilian corporation. This should improve understanding of the principles involved, the components of the system, and the benefits that can be expected.

The focus of the research will then be on answering the remaining six subordinate questions identified in chapter 1. The scope will be limited to just a one theater war, understanding that a second, near-simultaneous war raises additional concerns and challenges. Assumptions, as mentioned earlier, will be used in the analysis.

This will require an exhaustive study of the literature identified in chapter 2. As stated earlier, special attention is given to those sources authored by senior military logisticians who have peacetime, deployment, and wartime logistics experience. Next, attention is given to those sources providing information on JIT, employment of it in the civilian sector, and the Army's adoption of it. Finally, the research will utilize available CASCOM sources to determine JIT progress thus far, and projections for its wartime requirements and capabilities. Answering these subordinate questions will provide the necessary research criteria to use for analysis in answering the primary thesis question.

Finally, based on all of the information mentioned above, the research moves to a comprehensive qualitative analysis to determine, or assess, if JIT-principled logistics will

support an MTW. This will lead to the final chapter, which will include conclusions and recommendations developed as a result of this analysis. At this point the research will have reached its objective of answering the main thesis question.

CHAPTER 4

FINDINGS AND ANALYSIS

The research in chapter 4 will begin by covering the functioning of Army logistics historically (how the Army has always done it). This historical perspective will show how top military logisticians have long advocated many of the principles of JIT while recommending changes to logistic support. From this background, the research will then provide a more in-depth understanding of the history and development of JIT. The third part of this chapter will cover how civilian companies have applied JIT, including a comparison of a civilian system to the Army system, and the factors that have caused the Army to adopt JIT. Then, with the foundation laid, the research will include a definition and description of what JIT is in the U.S. Army. That will be followed by an analysis of JIT as an interwar phenomenon, which will lead to an analysis of the infrastructure, to determine if it is in place to support a transition to a major theater war. From that point, the research will make a qualitative assessment of logistics requirements for a major theater war and assess the capability of JIT to meet those needs.

Army Logistics before JIT

At its most basic, this portion of the study will answer one of the supporting questions. Has logistics support been adequate for previous U.S. Army operations? Historical lessons from the Revolutionary War through our most recent operations other than war (OOTW) deployments can offer many examples of logistics success and many of the reasons why. A study of these operations leads to the conclusion that while the Army's logistics support enabled its commanders to fight and win, there was much room for improvement. Areas needing improvement in our most recent operations have the

most to offer to the research. Specifically, the research will focus on lessons learned during Korea, Vietnam, and Desert Storm and the analysis provided by such experienced military logisticians as Rear Admiral (Retired) Henry E. Eccles, General (Retired) Carter B. Magruder, Lieutenant General (Retired) Joseph Heiser, and Lieutenant General (Retired) William G. Pagonis.

Historically, the Army, specifically, the Army Materiel Command (AMC), has always procured large amounts of repair and replacement parts with the acquisition of new equipment. There were a number of reasons why this was done. Financially, the dollars for the procurement of a new system often included a specific overage for these parts. If the funds were not spent on these parts the dollars were lost and the equipment would compete against other fielded systems for replacement parts funding. Another reason for this was because the industry producing the item was often retooled for the production of the military equipment and then refitted for production of commercial goods after filling the military contract. Making many extra components up front was easier for the manufacturer. It also met the Army's requirement for a large on-hand quantity of spare components for contingencies.

Once these parts were in the Army logistics system, AMC distributed them to the different theaters, where they were passed down to Corps Support Commands (COSCOMs) who maintained a stockage level on hand and passed the remainder down to Division Support Commands (DISCOMs). At the DISCOM level these parts were distributed to units based upon an established demand criteria, the most recent before JIT implementation was six and three: six demands for a part within 180 days to add a part to the unit PLL, then three demands within subsequent 180-day periods to maintain the part

on the unit PLL. The DISCOM also maintained a stockage on-hand based on their ASL. The manpower requirements to maintain these stockages at each level were significant. Additionally, parts were often to be found defective when they were installed and since the part was bought years before, it was difficult to hold the manufacturers accountable.

This system was in place for many years in the U.S. Army. During the interwar years between World War I and World War II, between World War II and Korea, and between Korea and Vietnam it was not uncommon for materiel to be left in place due to the large amount of on hand stock to support that particular item. Replacement of a piece of equipment entailed the replacement of the large stockage that went along with it.

Rear Admiral (Retired) Eccles' *Logistics in the National Defense* covers six major themes that directly relate to the move to JIT practices in the U.S. Army (see appendix B). While he offers a historical perspective on military logistics, his focus is on the strategic level. Still, within his major themes and his discussion of priorities and allocations, he identifies some problems with the logistics system that supported World War II and Korea. In World War II there was an identified need for a faster system, which better met commander's requirements while reducing excess. This led to the change to the Modern Army Supply System (MASS) in 1956. "The major feature of the system is that it uses the latest methods of communication, data processing, and rapid transportation to reduce the variety and quantity of items stored in combat and communications zones, thus reducing the size of the depots and the number of personnel in these zones" (Eccles 1959, 110).

General (Retired) Magruder's *Recurring Logistic Problems as I Have Observed Them* was completed during the Vietnam War and provides many insights from a

professional military logistician who served from the end of World War I until 1961. He addressed the steady reduction of logistics personnel in Army organizations, especially during interwar periods. He cited the problems with handling excesses and surpluses in war and how to prevent it. He devoted the last ten pages to a compilation of the top thirty one lessons he learned during his long career. His comparison of military and civilian cost-effectiveness requirements is especially important to this study.

> Cost-effectiveness is a valid consideration for military purposes only if the cost factor includes consideration not only of dollars but also of lives lost, lives blighted by wounds, and the effects of a national defeat. For commercial transactions, the cost factor is properly measured in dollars because the basic purpose of commercial transactions, is to make a profit in dollars. For military transactions the cost factor must be modified because the basic purpose of military transactions is success in war. Accordingly, effectiveness, in addition to having a relationship to dollars, also bears a relationship to casualties, wounds and the successful outcome of a war. Since the value of lives, health, and victory is difficult to determine, it is usually desirable to use cost-effectiveness only in deciding which of several roughly equally effective systems should be acquired. Where the systems are not equally effective, it is better to provide the best system or item that can be developed at its lowest reasonable cost. (Magruder 1988, 126)

Lieutenant General (Retired) Heiser's *A Soldier Supporting Soldiers* is an autobiography of the author while also serving as a biography of military logistics during his career, which spanned from 1943 to 1974, and included participation in World War II, Korea and Vietnam. His "logistics imperatives" (see appendix C) is a compilation of the most significant aspects of logistics that deserve attention. His assessment of military logistics support to combat operations is a positive one, but he is forthright in identifying what could be done better. The excesses and surpluses that Magruder wrote about are mentioned again, with proposed solutions for reducing them. The perspective offered by Heiser, including his imperatives, are very relevant to the Army adoption of JIT, as JIT offers solutions to the major deficiencies he identified during his long career.

Lieutenant General (Retired) Pagonis' *Moving Mountains: Lessons in Leadership and Logistics from the Gulf War* offers his autobiographical account of the myriad logistics problems encountered and solved during Operations Desert Shield and Desert Storm. While he spends much of his time documenting the innovative and flexible solutions used during our most recent major conflict, he also offers some observations on what needs to be fixed to facilitate similar success in the future. Of particular note is his discussion of the huge need for adequate transportation assets to ensure timely support and an observation similar to Magruder's concerning the assessment of cost-effectiveness in the military (Pagonis 1992, 210).

The histories provided by these senior logisticians offered insight into how military logistics functioned from World War I through Operation Desert Storm. Following the U.S. Army's redeployment from Desert Storm in the early 1990s, the military drawdown began. The resource constraints became especially profound in the logistics arena. The personnel drawdown left fewer logisticians to manage, maintain, and move the large quantities of on-hand inventory. The reduced budget left the logisticians in competition with the rest of the Army for scarce dollars. These constrained resources forced the Army to look to find more efficient logistics methods. As the Army looked at the private sector, the most promising solution seemed to be JIT logistics.

As the Army pursued making this profound change in its logistics practices it had to accept some facts unique to the Army with which civilian corporations did not have to deal. The Army has a mass-based logistics organization with many layers and functional bureaucracies. The Army, due to its size and culture, is slow to implement technologies. For the same reasons, the Army is slow to change organizational structures. Finally,

despite a major emphasis on improving acquisition procedures, the Army is still hampered by acquisition regulations. With these factors in mind, the Army began to pursue JIT practices to provide a more cost-efficient logistics structure.

The Basics of JIT

This is essentially answering another of the supporting questions. What exactly is JIT? JIT principles advocate getting the right item to the right place at the right time. This contrasts with the old standard of maintaining large inventories of items on-hand, readily available to the user.

Originally proposed during the aftermath of World War II, JIT was initially adopted only by the rebuilding Japanese industries. Their success with this system, combined with the advancement of information technologies and ever-faster transportation systems, finally led to its widespread adoption in American companies in the late 1980s and 1990s. This thesis will further define all the components of JIT, and the existing or projected Army systems that will support these components.

In postwar Japan, the rebuilding economy was looking for solutions that would get industry back on its feet, but in an economical manner. General Douglas MacArthur was the first to suggest the JIT principles now so common. JIT was ideal for Japanese industry. JIT required having just the right amount of raw materials, stock, or equipment on-hand, at just the right time. The geography and culture of Japan made this easy. There was no need for a large supply of steel on hand at the factory when it could be delivered within hours. The small distances involved meant turnaround time between request and supply was minimal. This is a key component of JIT, turn around time

between identified need and satisfied customer. Additionally, the Japanese culture was very conducive to employ support and improvement of manufacturing techniques.

This also led to quality improvements. If a part arrived on hand, right when it was needed, it was immediately identified as suitable or unsuitable, if it was unsuitable, the supplier would have to replace it with a suitable component. This made the manufacturer improve his quality, because he never had to resort to using substandard components. This made the supplier improve his quality because his faults were identified immediately and he could take corrective actions. The close proximity also made communications between suppliers and manufacturers easy, as much of it was face to face.

These initiatives could not be implemented in the U.S. during the 1950s, 1960s, or 1970s due to the large distances separating the suppliers and manufacturers. The travel distance was not the only factor, for the large amount of interaction necessary in a JIT system, a communications system was also necessary. In the early 1980s, the systems were in place that would support some companies, those with the information and technology necessary to provide the communication and interaction. Transportation systems were able to respond more quickly and get parts and supplies to manufacturers in only a fraction of the time. A change to JIT was often used as a last resort due to the necessary organizational and cultural changes within the company.

Dr. W. Edwards Deming, an internationally renowned management and manufacturing consultant, is generally acknowledged as the first to formalize the management philosophy known as the JIT concept. This concept calls for continually decreasing total inventory levels by decreasing the lot size, buffer stocks, work in

process, and in-plant inventory. Lower inventory levels correlates to lower capital investment and improved product quality. JIT further emphasizes the goal of constant improvement and better risk analysis.

For better understanding, it is useful to describe the characteristics of JIT using a listing of the components of an ideal operating environment. The ideal environment for JIT is described as one where (McGee 1994, 17):

1. The primary application of JIT is in new item manufacturing.
2. All systems work efficiently.
3. There is limited fluctuation in supply and demand.
4. There is minimal administrative burden.
5. Supplies are in small lots with frequent deliveries.
6. A zero balance or out of stock is unlikely but not extremely undesirable.
7. Safety stock is considered excess.
8. Localized geographic concentration of suppliers
9. A controlled transportation system
10. Strong vendor relationships
11. Employee and management commitment

Two specific focus areas within JIT are purchasing and transportation. Purchasing in a JIT system requires purchases of small quantities with frequent deliveries. Additionally, a single source of supply is desired for a given item, in close proximity, with a long-term contract. The primary objective of JIT purchasing is to achieve product quality and a fair price through long-term contracts.

Transportation in a JIT system is critical. It can effectively determine success or failure of the JIT operation. As mentioned above, with frequent deliveries of small quantities, the transportation system must support frequent deliveries. Slower methods of transportation, such as rail and shipping, have a detrimental effect on JIT operations. Trucking and air cargo shipments are ideal for the JIT system, as they greatly shorten the transportation time while being more adaptable for small quantity configurations.

When comparing the U.S. Army logistic system described at the beginning of this chapter with the description of the ideal environment for JIT, it is evident there was a broad gap between the two. Looking at the items that Eccles and Heiser identified as needing additional attention in military logistics, it seems that JIT can offer appropriate solutions.

Why the Army Adopted JIT

The economic advantages of JIT are only matched by the quality increases it offers. JIT is economically efficient because the items are only bought in the quantities needed, at the time they are needed. No excess quantities are bought. This reduces numerous other overhead costs for maintenance of inventory, which usually includes rental or construction of warehouse facilities, information systems to track inventory, and manpower to manage the inventory. JIT improves quality because manufacturer-to-user timelines are decreased, reducing on-shelf failure and obsolescence, as well as providing the conditions for the user to provide timely feedback to the manufacturer on quality control.

The decision to implement JIT was a simple one for corporations, but a difficult one for the U.S.Army due to the differing factors in determining cost-effectiveness as

described by Magruder and Pagonis. There are numerous publications that describe the military's study of JIT and the reasons why it is appealing. These publications are sometimes biased, as the military tends to advocate the systems it has adopted and naysayers often are zealous in their rejection of new systems.

Department of Defense Instruction (DODI) 4140.11, dated 24 June 1958, established the basis for an economical inventory in the military. The DODI established a policy for peacetime operations of supply on the most economical basis considering military necessity, which is based on repetitive demands of secondary items. This economical inventory policy (EIP) incorporates a statistical representation of demand, safety level quantities, and minimum operating level quantities into a system that emphasizes a balance between costs to order and costs to hold. This balance accomplishes the main goal of EIP, which is to minimize total variable costs.

Inventory management within the Department of the Army (DOA) involves the widest variety and the largest inventories of material found in any organization in the free world. These inventories include equipment and supplies held in DOA storage facilities and in transit. The DOA selectively manages about 2 million items and strives to meet two primary objectives. The first is to maximize support to Army forces and the second is to do so at minimal support costs. This information about Economic Inventory Policy and Economic Order Quantity are included in the curriculum of the Logistics Executive Development Course taught at the Army Logistics Management College at Fort Lee, Virginia.

Due to the size and complexity of the Army inventory system, it is necessary to segment material into two categories, primary items and secondary items. Primary items

are end items and replacement assemblies, such as tanks, ships, and planes. Secondary items, repair parts, are managed, procured, and issued based on their usage, usually in accordance with the PLL and ASL criteria mentioned previously. Additionally, the DOA supply system is divided into wholesale and retail levels, similar in name, nature and scope to private industry. The wholesale level buys from industry and provides support to the retail level; this is the role of AMC and the COMMZ in Army terminology. The retail level supports the user directly in the field, this is the support provided from the COMMZ down through the COSCOMs and DISCOMs to their supported units.

Inventory management is comprised of six functions: requirements determination, catalog direction, procurement direction, distribution direction, maintenance direction, and reutilization and disposal direction. The secondary item manager performs the requirements determination and directs the other five functions be performed by the appropriate organization. The requirements determination function is an area where a direct correlation can be seen between the Army and civilian corporations, and the corresponding benefits offered by JIT (see appendix D).

The inventory manager must make two decisions when using EIP, how much to buy and how often to buy. The determination of how often to order is relatively simple and is based on historical data and projections to determine the optimum quantity of stock to maintain on-hand to meet the demand without going out of stock. PLL, ASL, and unit inputs assist the inventory manager with this decision.

How much to buy is more difficult to determine. While PLL, ASL, and unit inputs also affect this decision, there are also other variables. The Economic Order Quantity (EOQ) is the "how much to buy" and is designed to obtain the optimum

quantity of material that will result in the lowest total variable cost. The total variable consists of ordering costs and holding costs. These costs are further broken down to encompass costs that vary by quantity and by the number of orders placed. These are described as variable ordering costs and variable holding costs. Variable ordering costs take into consideration direct and indirect labor costs, support costs, and shipping and packaging costs. Variable holding costs take into consideration investment costs, obsolescence costs, storage costs, and other losses, such as pilferage.

The combination of ordering costs and holding costs will produce a total variable cost. A change in one will affect the other and the total variable costs. Ordering costs vary inversely with holding costs. There is a level at which the combined variable costs of ordering and holding inventory are at a minimum. The size of the order which produces this optimal solution is the EOQ and is derived by the following formula:

$$EOQ = \sqrt{\frac{2CY}{HU}}$$

where: Y= the yearly demands

C= the cost to place an order

H= the cost hold an item

U= unit costs

Requirements determination under the JIT concept greatly simplifies the EOQ model explained above. Since the primary application of JIT is in new item manufacturing, manufacturers can base requirements on projected sales. Sales managers forecast sales based on history and experience, aiming for ninety percent accuracy. These sales forecasts are used to estimate the parts that will be needed. The assembly

plant confirms the sales projections and parts estimates well before scheduled assembly. After confirmation, a release order is cut to the appropriate manufacturer to order the required parts from the suppliers. This results in the total cost being only the stockage cost plus whatever zero balance and restock cost is incurred. The added simplicity of this system requires less manpower, incurs less error, and is more receptive to changing situations. While the requirements determination process graphically displays one benefit of a move to a JIT system, there were many other benefits that caused the Army to take note of what was going on in the civilian sector.

As the Army looked to the civilian sector for successful companies with JIT practices in the early 1990s, there were a few who were clearly benefiting from their change. Three large organizations that stood out were Harley-Davidson, Omark Industries, and Sandia National Laboratories. Through implementation of JIT, all of these companies reduced inventories, improved quality, and increased responsiveness and flexibility.

In 1983, Red Blount, of Blount International, went to Japan to learn how successful manufacturing companies operated. On the trip he asked a Japanese expert which American company had most successfully adopted Japanese manufacturing techniques. The answer was Omark Industries of Portland, Oregon. In January 1985 Blount International acquired Omark, the world's leading manufacturer of saw chain and timber harvesting equipment. Many of the JIT practices in place at Omark have been applied to the other companies within Blount International (Blount International, 2000).

Omark Industries reaped the benefits of successfully implementing JIT. The overall results of implementing JIT at Omark Industries were a decrease in total

inventory by 45 percent, lead times falling from days to minutes, and work in process inventories decreasing from sixty pieces to one (Taylor 1992, 16).

There is a similar story of success at Sandia National Laboratories. Sandia is a national security laboratory operated for the U.S. Department of Energy by the Sandia Corporation, a Lockheed Martin Company. Sandia National Laboratories began in 1945 on Sandia Base in Albuquerque, New Mexico, as Z Division, part of what is now Los Alamos National Lab. The Manhattan Project, the nation's first atomic bomb development effort, was the genesis for both of these labs. Sandia was founded as an ordnance design, testing, and assembly facility and was located at Sandia Base to be close to an airfield and to facilitate closer work with the military. In 1949, at President Truman's request, AT&T assumed management of Sandia, a relationship that lasted for forty-four years (Sandia National Laboratories, 2000).

The labs' original mission, providing engineering design for all nonnuclear components of the nation's nuclear weapons, continues today, but Sandia now also performs a wide variety of national security research and development work. They design all non-nuclear components for the nation's nuclear weapons, perform a wide variety of energy research and development projects, and work on assignments that respond to national security threats, both military and economic. They encourage and seek partnerships with appropriate U.S. industry and government groups to collaborate on emerging technologies that support their mission (Sandia National Laboratories, 2000).

At Sandia JIT had even a more marked positive effect on operations. The JIT program there eliminated $7.2 million worth of inventory. The company also reaped a windfall in yearly operating expenses. Inventory carrying costs were reduced by

$720,000 a year and labor savings of $2.3 million a year were achieved through the elimination of warehousing and servicing tasks. Since the implementation of JIT, Sandia has been able to achieve annual savings of approximately $8 million (Taylor 1992, 17).

Harley-Davidson (H-D) implemented JIT in 1982 with impressive results. H-D will be used as the civilian example of successful JIT implementation to show the factors that led to the Army adopting JIT. It is only coincidental to this thesis that this company survives today as the oldest American motorcycle company due to Army contracts in World War II.

Harley-Davidson, a subsidiary of American Machine and Foundry (AMF) in 1981, was suffering from poor quality and decreasing market share when thirteen managers got loans totaling $81.5 million for a leveraged buy-out. The immediate goals of the new management mirror those sought by the Army in the 1990s; improved quality, reduced on-hand inventory, reduced manpower, and reduced costs. H-D accomplished those goals by implementing JIT, improving their information systems (IS), and streamlining communication from the customer to management (Reid 1990, 73).

Since implementing these changes, H-D has seen many improvements. One of the first things JIT did for H-D was to stabilize production schedules. This allowed parts suppliers to get into a routine of delivering the same mix and quantity of parts daily. Additionally, JIT allowed H-D to reduce set up times an average of seventy five percent. The implementation of JIT at H-D also led to a thirty percent increase in productivity. All of these internal improvements at H-D resulted in a higher quality product on the market, which allowed them to recapture the market they used to dominate, increasing

from a twenty three percent market share in 1983 to a sixty four percent market share in 1993 (Kelly 1993, 58).

Soon after the company recaptured the market in superheavyweight motorcycles, it went public with stock offerings, increased production, and continued to improve quality. JIT at Harley-Davidson is known as MAN (material as needed). MAN has allowed the company to free up cash for research and development, allowing them to compete in the market and improve customer satisfaction. Hand in hand with MAN is EI (employee involvement), this has allowed the workers at the lower levels to develop solutions to manufacturing problems, then pass them up through the corporate chain of command for dissemination. A third component is SOC (statistical operator controls), on the assembly line this means having machines and systems in place to statistically track quality, performance and efficiency. The underlying source for integration and success of these three components was an improved IS structure (Reid 1990, 73).

Harley-Davidson offers many examples of success and many methods for achieving it. It enters the twenty first century stronger than ever before. JIT in the private sector resulted in extraordinary savings in inventory reduction costs, increases in quality, and reduced manpower needs. Looking for the same type improvements in a resource-constrained environment led the Army to adopt JIT techniques.

Velocity Management, the Army's JIT Solution

"There will not be a revolution in military affairs unless there is a revolution in logistics. This means putting our faith in concepts like velocity management and total asset visibility, giving up the comfort of stockpiling supplies on an iron mountain." With

these words in 1998, General Reimer, Army Chief of Staff, emphasized the importance of velocity management (VM) to the Army today (CASCOM 2000i, 2).

With this charter the CSA also directed CASCOM, as the executive agent, to implement the velocity management program. The underlying principle of velocity management is similar to other JIT practices; replace mass with speed and accuracy to provide a better, faster, and cheaper way of doing business.

A velocity management brief by the CASCOM leadership in 1999 provided a vision statement for velocity management implementation in the Army. " Streamline the Army's logistics processes to ensure that soldiers receive the same quality of service that they would if the service were provided by a commercial firm. Provide commanders in the field the tools to identify problem areas through the use of performance based metrics and reports" (CASCOM 2000i, 13).

Velocity management was established on 20 January 1995 when the first session of the Velocity Group (VG) convened. The velocity group is a coalition of flag officers and senior executive service civilians with a common vision: the need for change and the commitment to span the inherent organizational functionalism essential to bring about that change. The velocity group guides and supports velocity management institutionalization. It provides the leadership and vision for change, sets broad goals and guidelines, defines the scope and pace of implementation, and helps waive outdated regulations and other official policies. The velocity group also interfaces and coordinates with DOD players, such as United States Transportation Command (USTRANSCOM), the Defense Logistics Agency (DLA), and the Office of the Secretary of Defense (OSD).

The velocity group provides high-level program course directions/corrections and ensures institutional commitment to velocity management. Velocity management includes cross- functional teams imbedded in the system to ensure it is dynamic, changing, and improving to meet Army needs. With the CASCOM Commanding General as the executive agent, the program was structured with the velocity group, change agents, RAND, process improvement teams, and site improvement teams built into the system (CASCOM 2000i, 5) (see appendix E).

The velocity group is now supported with a total of eight process improvement teams (PITs). The process improvement teams are: the Order and Ship PIT (O&S PIT), the Repair Cycle PIT (RC PIT), the Stockage Determination PIT (SD PIT), the Financial Management PIT (FIN PIT), the Deployed Operations PIT (DO PIT), the Transportation PIT (TRANS PIT), the United States Army Reserve PIT (USAR PIT), and the Army National Guard PIT (ARNG PIT).

The order and ship process improvement team is established to dramatically improve the Army's ordering and shipping processes. Its charter is to identify and eliminate nonvalue-adding activities and improve value-adding order and ship activities and processes used by the Army. Approval and implementation of specific actions developed by this process improvement team will make ordering and shipping processes more efficient and responsive to the customer (CASCOM 2000d).

The O&S PIT defines order-ship time (OST) as "the time elapsed from requisition of an item to receipt of the item by the user." The baseline for order-ship time was determined by averaging OSTs from 1 July 1994 through 30 June 1995. During that time the average order-ship time was 26.5 days. Velocity management processes, at the

direction of the velocity group, have reduced the OST in CONUS to 9.5 days in fiscal year 1999 and the goal for fiscal year 2000 is six days (see appendix F).

The repair cycle process improvement team is established to drastically improve the Army's repair cycle processes. Its objective is to reduce future end item and component repair cycle time (RCT) by 50 percent over the baseline period (fiscal year 1996). The baseline for depot items is fiscal year 1997. Approval and implementation of specific actions developed by this process improvement team will make maintenance processes more efficient and responsive to the customer. RCT is defined as all time required to repair parts from the time it is identified in the motor pool, through the depot, to when the part is ready for the user (CASCOM 2000e).

The stockage determination process improvement team is established to develop stockage policy and procedures to reduce inventory and leverage distribution to create efficiencies and cost savings without decreasing readiness. Its charter is to identify and eliminate nonvalue-adding activities and improve value-adding stockage determination activities and processes used by the Army. Approval and implementation of specific actions developed by this process improvement teams will make stockage determination processes more efficient and responsive to the customer. The stockage determination process improvement team defines SD as "stocking the right parts at the right place to ensure uninterrupted logistics support." Initially this team focused their effort toward validating ASLs, PLLs, and bench and shop stocks. Their focus is now on alternative stockage methods, with their most important focus on ensuring support for the transition to war (CASCOM 2000f).

The financial management process improvement team is established to apply the velocity management methodology to reevaluate and improve the Army's financial performance process and its integration with the logistics process. The financial management process improvement team's charter is to identify and eliminate nonvalue-adding activities and improve value-adding financial management activities and processes used by the Army's logistics systems. Approval and implementation of specific actions developed by this process improvement team will make financial management processes more efficient and responsive to the logistics community (CASCOM 2000c).

The deployed operations process improvement team is established in order to dramatically improve logistics support (transportation, supply, and maintenance) throughout the deployment process of an Army force, forward deployed in support of a contingency operation (combat, peacekeeping, humanitarian, or disaster relief). Its charter is to identify and eliminate nonvalue-adding activities and improve value-adding logistics activities and processes used by the Army throughout the operation. The deployed operations process improvement team will serve as the integrator of process improvement actions for logistics that are related to deployed operations. Approval and implementation of specific actions developed by this process improvement team will make logistics processes throughout the operation more efficient and responsive to the customer (CASCOM 2000b).

The transportation process improvement team is established to apply the velocity management methodology to reevaluate and improve the Army's transportation performance process and its integration with the global transportation system. The

transportation process improvement team's charter is to identify and eliminate nonvalue-adding activities and processes and improve value-adding transportation activities and processes used by the Army's transportation network and global transportation system. Approval and implementation of specific actions developed by this transportation process improvement team will make transportation processes more efficient and responsive to the logistics community (CASCOM 2000g).

The United States Army Reserve process improvement team and the Army National Guard process improvement team are established to apply the velocity management methodology to reevaluate and improve the USAR and ARNG performance processes and their integration with the logistics process. Their charters are to identify and eliminate nonvalue-adding activities and improve value-adding USAR and ARNG activities and processes used by the Army's logistics systems. Approval and implementation of specific actions developed by these process improvement teams will make USAR and ARNG processes more efficient and responsive to the logistics community (CASCOM 2000a; and CASCOM 2000h).

The site improvement teams (SITs) are located at installations based on command needs. The velocity group may recommend a site improvement team for a specific location or command, or the local commander may direct one be established. The site improvement team has a similar charter to the process improvement team, with the focus being on the site or unit supported rather than on a single process.

The velocity management methodology is a continuous process similar to the Army training cycle methodology. The first step is to define the process, this includes all those measures to determine customer needs, inputs, and system outputs. The next step is

to measure process performance, including defining performance metrics, identifying critical data needs, and developing standards for reporting performance. The third step is to improve the process by establishing goals, improving process design, and implementing change. This methodology is commonly referred to as the D-M-I (define, measure, improve) methodology. These steps, in turn, lead back to the first step, as the process must be redefined after every change (CASCOM 2000i, 11)(see appendix G).

The velocity management implementation team identified some potential obstacles to the program. One of the primary obstacles is the Army's resistance to change and the tendency to maintain the status quo in our comfort zone. Job protection was another concern, as velocity management requires less manpower and management. There was the historical Army logistics culture to overcome; any change would have to contend with this obstacle. Identifying these obstacles, and others, helped CASCOM identify some enablers that would be key to the implementation of the new program.

Leadership interest had to be generated. This was done through numerous media, but the key was to inform the commanders what was coming and how it could benefit the Army. Tactics, Techniques, and Procedures (TTP) had to be disseminated, and this was done through the generation of handbooks about the new program distributed at the appropriate levels. As mentioned earlier, IS is a key component of any JIT system, in the case of velocity management it involved updating existing Army systems and automating other processes.

Velocity management implementation has produced many of the desired outcomes. The cost savings have already exceeded $400 million as stocks have been reduced throughout the system. Order-ship time has been reduced to almost a third of

what it was prior to velocity management. For the improvements being sought, Velocity management has proven effective so far.

VM as an Interwar Period Phenomenon

Previous interwar periods in the U.S. have seen the adoption of some unique solutions to maintain the Army's readiness in preparation for the next war. The Army has many "lessons learned" from these periods, as the first days of each conflict usually revealed the weaknesses of the interwar preparations. If this is just an interwar phenomenon, then it indicates the Army is consciously choosing peacetime efficiency in logistics to free dollars for other Army concerns during this time of limited resources. General Reimer stated that the revolution in military affairs is dependent upon velocity management, indicating that logistics efficiencies are bill payers for other systems during the tight budget common to all interwar periods. If velocity management was adopted as a best business practice, it is important to analyze it from the basis laid down by Magruder and Pagonis in their assessments in the difference between private industry cost effectiveness (profit), and military cost effectiveness (lives and victory).

As bureaucracies, military organizations are inherently resistant to change (Rosen 1994, 2). This is a positive aspect when you consider the time and effort it would require to completely destroy a military. The bureaucratic nature demands that redundant efforts be made to effect change, which safeguards the traditions, customs, values, and doctrine of the organization. During wartime, survival of the force becomes the main motivator for change, which is why change occurs much faster during war than during peace. The bureaucratic nature of the military can be seen as an obstacle during peacetime, but it must be overcome in order to prepare the military for the next war. It was easy to

overcome many of the bureaucratic obstacles with velocity management because of the efficiencies it offers.

Another obstacle to change between wars is public disinterest or general revulsion against warfare and all things military. This is manifested today by the recruiting and retention difficulties the Army is having. This also leads to a "tightening of the purse strings" which can slow military efforts to develop and procure the systems necessary to wage the next war. In past interwar periods this reduced military budget made the U.S. government reluctant to "chase technology" but the current world environment requires the Army to maintain technological dominance. As technology advances so quickly, and in so many areas, it is difficult for the military to determine which technological innovations offer marked increases in capabilities. There are incredible parallels between the current interwar period and the interwar period between World War I and World War II (House 1984, 44).

Another major obstacle to change during interwar years is the inability of the military to "speak with one voice" about necessary changes. Reformers are often too zealous in their pursuit of their cause so that they alienate their brethren in arms, causing the government to have no clear consensus on what the military really wants. This can be seen today with the constant bickering in Washington between each branch of the service over the many Force XXI projects. Traditional roles for the combat arms and the services are also a factor in this argument, as the traditionalists argue for more ground combat capabilities while others advocate an increase in air capabilities and missions.

In peacetime, there are certain triggers for change that guide the military in its evolution to being prepared for the next war. The threat is a major trigger for change, as

the U.S. military does not want to enter the next conflict outmatched by any foe. In the current timeframe, identification of the threat is more difficult than ever before, making threat-based acquisitions and proposals more difficult to defend. To best posture itself for any foe, the Army has made a concerted effort to gain resource efficiencies in all possible areas to free precious dollars for those systems with the most flexible capabilities.

Proxy wars are another trigger for change. In the current timeframe, proxy wars have been supplanted by operations other than war (OOTW). These contingencies, while increasing OPTEMPO and stretching precious resources, can offer test beds for development and experimentation. In the logistics arena, the recent deployments have validated the concept of contractors on the battlefield. The deployed operations process improvement team is also gaining invaluable experience in deployment logistics, sustainment over extended lines of communications, and the exercise of army logistics systems in relatively austere environments. Input from the deployed operations process improvement team is disseminated throughout the logistics community via the velocity group, resulting in increased deployment capabilities Army-wide.

Technology is a major trigger for change, as well as sometimes being an obstacle, as stated above. Available technology from the U.S., allied nations, threat nations, and the often-neutral scientific community requires that the Army effect change to make best use of it. Technology must be evaluated to determine what capabilities it offers, and when possible, off the shelf purchases are made to test and evaluate items before they are adopted. While studying these capabilities within the training areas and labs of this country, the Army is also observing what other nations are doing with these technologies.

The ability of the U.S. Army to maintain a technological edge is crucial to success in an MTW. The efficiencies provided by velocity management have greatly increased technology acquisitions in the military, many within the logistics community.

Another significant factor in triggering change is the incorporation of lessons learned. The lessons learned can come from the previous war or from the most recent contingency operation. The Army's most recent experiences have provided the impetus for numerous changes. The swift combat actions in Operation Desert Storm indicated the need for a more mobile and robust logistics structure. The recent deployments to the Balkans have indicated a need for better interaction between Active and Reserve components as well as a need for more joint and combined training at all levels. The Army training centers and the Center for Army Lessons Learned (CALL) are still more tools the Army can use to maximize positive change from lessons learned.

Dramatic cuts in resources can be a very effective trigger for change between wars. In the case of velocity management, this was the trigger that made it happen. A reduction in the Army's huge logistics budget frees dollars for other activities. As stated above, the Chief of Staff of the Army knew that there could not be a revolution in military affairs unless there was a revolution in military logistics, including the adoption of velocity management. "Doing more with less" offers the Army a chance to increase its efficiencies while building a disciplined and compliant logistics structure. Peacetime frugality can often result in wartime efficiency.

As mentioned earlier, lessons learned from recent deployments and military studies are analyzed extensively. These often lead to simulations that are beneficial to the U.S. Army's preparation for the next war. These simulations now encompass logistics

functions as well as warfighting functions. Recent AWEs and CSS Battle Lab simulations have provided invaluable insights into Army After Next (AAN) logistics concerns. Velocity management has been included in each of these simulations, to varying degrees. This indicates the Army's dedication to velocity management for the foreseeable future.

This analysis indicates that the interwar period conditions of limited and competing resources, and experience gained from Operation Desert Storm and recent deployments were the triggers that led to the adoption of velocity management. However, the success of velocity management, and its inclusion in the most recent simulations, indicates that its processes are sound and that it is likely to be a major factor in Army logistics for Force XXI and beyond. As a peacetime solution it has provided all desired benefits, now this study will determine if it can support an MTW.

Velocity Management Support in an MTW

This analysis will determine the suitability of velocity management in supporting an MTW. The requirements were determined from scenario-driven simulations conducted at all levels. Sources for the information used in the analysis include MTW requirements as specified in the National Military Strategy, AMC power projection assessments, studies conducted by RAND, CSS Battle Lab reports, and NTC rotation results.

The current contingency plans to support the two MTW scenario require mobility support to deploy three divisions into the theater of operations within thirty days and two more divisions, with a sustainment base, in the next forty-five days. These contingency plans rely on CONUS-based power projection platforms, including fifteen installations,

fourteen airfields, seventeen strategic seaports, and eleven ammunition depots and plants. The Army also monitors the Air Force's procurement of C-17 Globemaster IIIs and additional Roll On/ Roll Off (RORO) ships by the Navy. Currently only forty seven of the required 134 C-17s have been delivered and only eight of the Navy's nineteen required RORO ships have been delivered. To assist in the contingency plans AMC currently manages seven pre-positioned Brigade sets. All of these assets form the basis for the Army's rapid power projection capabilities (U.S. Department of the Army 2000).

Joseph Heiser is widely studied and referenced for his expertise on wartime logistics, especially his knowledge of logistics support in Vietnam. As a logistics expert, the imperatives he described will be used as an evaluation tool of the suitability of velocity management in an MTW. The information will now be measured against the ten "logistics imperatives" described earlier (see appendix C).

1. Involve the commander in all aspects of logistics.

The emphasis on supporting velocity management begins at the top with the endorsement of the CSA. The velocity group provides additional impetus for command involvement. Velocity management requires commander input. In peacetime the involvement of the commander is solicited through the site improvement teams located throughout the Army. Commanders who properly employ velocity management principles see real improvements in equipment readiness rates and cost efficiencies.

Scenario-driven simulations have identified the need for additional commander emphasis on logistics planning during combat operations. While logistics cycle times are reduced to as low as twelve hours, modern weapons have reduced battle times to about two hours. This 6:1 ratio of log time to combat time would be unacceptable in a

high intensity conflict environment. This requires the logistician to anticipate command needs; to accurately assess what is needed for the commander to ready his unit for the next short combat action. The ratio alone can be misleading, but it does highlight the need for increased logistics efficiencies to ensure the command's ability to sustain combat operations.

While mass-based logistics could offset the logistics cycle time with massed quantities of supplies, velocity management requires the combat commander to consider CSS planning and decision cycle effects on the battle rhythm. Additionally, much like Operation Desert Shield, a logistics command structure needs to be in place early in the deployment flow. Velocity management can add to the effectiveness of this early-entry logistics element through the establishment of a deployed operations process improvement team to assess and improve logistics functions of units deploying into the theater.

2. <u>Prioritize logistics requirements</u>.

The stockage determination process improvement team is responsible for determining the stockages of material maintained on-hand and requisitioned. The processes that were so effective in reducing inventory stockage levels in peacetime could serve equally well in increasing stockages as a contingency generates the need. In addition to prioritizing stockages, the stockage determination process improvement team, in cooperation with the deployed operations process improvement team, can prioritize the flow of these stockages to units based on their arrival in theater. These determinations will add greatly to the logistics preparation of the theater, impacting flow of logistics

resources into theater, composition of forward logistics elements, and providing logistics information to the deploying unit commanders.

The processes used in peacetime can be readily transferred to an MTW scenario, however, the plentiful and reliable transportation systems used for supplying units and installations will not be as readily available. Command involvement with logisticians will be necessary to ensure logistics assets get the proper priority coming into the theater. Recent wargames have indicated a need to update planning factors and allocation rules as well as reevaluating deployment PLLs and ASLs.

3. Ensure logistics support is consistent with requirements.

The logistician must know the commander's intent. The velocity group can serve as the executive agent to ensure this is accomplished. This will allow the logistician to anticipate the requirements of the mission and ensure resources are allocated properly to effect mission accomplishment. The D-M-I process of velocity management is ideal in making these determinations. Logistics planning must be given equal footing with operational planning early in the deployment process. With the need to maximize the combat forces early in the deployment, the logistics planners must exercise economy of logistics force. The personnel drawdown of the mid-1990s was a good test of the ability to support the Army with an economy of logistics force.

Logistics civilians on the battlefield, a standard during the Army's most recent deployments, will become even more critical in an MTW. In recent contingency operations the researcher has personally seen the added benefits of logistics contractors in the area of operations. The addition of contractors to the battlefield will affect the commanders, their planning staffs, and their risk assessment for the operation.

4. <u>Train logisticians under wartime conditions</u>.

Velocity management is a methodology consisting of processes between multi-functional agencies. These same agencies will conduct the same processes in an MTW that they conduct in peacetime. In the accomplishment of their peacetime duties they are "training as they will fight." However, as more and more civilians are utilized in the logistics system to free up manpower for the combat arms, it is essential that they be trained in all simulations, wargames, and exercises. The move from mass-based logistics to speed-based logistics results in industry having a more profound effect on soldiers in theater. For this reason, it is essential that industry partners participate fully in war games and scenarios to determine the most accurate requirements. Recent AWEs have shown the need for more industry representative involvement.

5. <u>Organize logistics systems in peacetime so they will function in war</u>.

The VM methodology ensures processes are in place to assure prompt support of critical items. As the units deploy into theaters, the process improvement teams will constantly be assessing the logistics structure with the D-M-I process. The play of process improvement teams in simulations and exercises is crucial, as their input to the improvement of the processes becomes more relevant as units deploy to an MTW. The velocity management organization in peacetime is postured to readily adapt to the changed conditions of an MTW, employ the same principles within the same processes, and then support an MTW. An added benefit of velocity management is the redundancy offered by the process improvement teams, as unit-level logisticians make the first attempt at solving a problem the process improvement team can be there ready to assist with solutions as well. The velocity group, which regularly exercises communications

through all command and logistics channels, will become even more important in focusing the Army logistics effort on support for an MTW.

6. <u>Incorporate commodity and functional capabilities into all echelons of logistics support</u>.

The velocity group ensures this happens in peacetime and ensures that velocity management is coordinated into all contingencies. Process improvement teams and site improvement teams ensure functional and commodity expertise is properly placed in the system. In wartime this will include interaction of all the process improvement teams and the installation site improvement teams of deploying units. The change agents are a check on the system, ensuring the intent of the velocity group and deploying commander is executed throughout the velocity management processes. In an MTW this becomes even more critical, as time lines for assessments and improvements will be shortened.

7. <u>Consider logistics constraints in establishing operational capabilities</u>.

There are some constraints that will require velocity group action. Inventory reductions coupled with less DOD influence on the industrial base will continue to adversely affect national security. Currently, AMC can only verify that industry can fully satisfy 17 to 24 percent of some war reserve shortfalls. The Army's decreased demands and small quantity of stock on-hand has resulted in a diminished replenishment capability in the Army and in the industrial base. Velocity management must ensure that commanders at all levels understand these constraints through decisions and guidance of the velocity group. Responsive policies of the process and site improvement teams can serve to lessen the effects of these constraints and maintain efficiency and effectiveness of the logistics system.

8. <u>Determine requirements based on factual data</u>.

The D-M-I process employed in the velocity management methodology is focused on making the data as accurate and factual as possible. All process and site improvement teams use this process to constantly monitor functions within their specific process or area of responsibility. This leads to the best possible data being used to determine requirements. With the transportation shortfalls identified earlier, the necessity for accurate requirements determination is increased. The huge efficiencies that velocity management has experienced should be readily transferable to the MTW environment. Additionally, the confidence in the system has already resulted in less hoarding of items and fewer duplicate demands for items. This confidence is a logistics force multiplier during an MTW.

9. <u>Be flexible in adapting capabilities to requirements</u>.

Velocity management is designed with the customer (unit commander) as the focus for all efforts. Responding to customer needs, being flexible, and being innovative in seeking improvements are all functions of the process improvement teams and site improvement teams, under the direction of the velocity group. The D-M-I process creates flexibility because it is, by nature, an instrument of change. The velocity group ensures command needs are known and then all necessary effort is focused to make the necessary adjustments or improvements.

10. <u>Learn from history for "the past is prologue</u>."

The velocity group has incorporated velocity management into the training at all Army logistics training facilities. All war game and simulation results are quickly disseminated throughout the logistics and command channels. Every simulation and

NTC rotation is considered a valuable learning tool to determine what works, what needs to be fixed, and what can be done to improve support to the commanders. Velocity management has established a site on the World Wide Web that allows logisticians and commanders to share velocity management and logistics related information. The history of logistics in the U.S. Army is a story of mass and excess. Velocity management instruction uses this history as part of its training for logisticians as a basis for their improvements, adding additional weight to the argument to replace mass with speed.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This study documents the research conducted to determine if Velocity Management can support an MTW. This report has a logical progression beginning with the history of Army logistics in this century. The primary sources for much of this history were senior military logisticians. Their experience and recommendations provided a focus for the research. Next, the just-in-time concept is defined and described, with some examples of its success in the private sector. This leads to the explanation of how and why the Army accepted just-in-time concepts and how Velocity Management was adopted in 1995. The report then provides a summarized history of Velocity Management and highlights many of the efficiencies it provides to the Army.

The findings in chapter 4 of this study build on the history of Army logistics and Velocity Management. The Army's adoption of Velocity Management resulted in numerous improvements in logistics support, but all during peacetime. The report examines Velocity Management as an interwar period phenomenon and then carries that analysis further to determine if Velocity Management can support an MTW.

The "logistics imperatives" of Lieutenant General (Retired) Heiser, a recognized expert in military logistics, provide an appropriate yardstick to measure the capabilities of Velocity Management in an MTW. A thorough analysis of the six subordinate questions provided in chapter 1 of this study is also found in chapter 4.

Velocity Management has delivered in all areas in the current peacetime environment. It provides unprecedented efficiencies in a reduced-manpower logistics structure in an environment of constrained resources. Improvements can be found in all

logistics processes. Initially starting with a focus on reducing order ship time and repair cycle time, Velocity Management now includes six other processes and shows signs of having similar success in those areas as well.

The most positive result of Velocity Management is the resultant increased confidence in logistics support. This confidence manifests itself in the continuing improvements in all processes and the increased compliance with Velocity Management principles across the Army. The recommendation for Army commanders is to continue the strong support of velocity management. In the case of Velocity Management, success truly fosters even greater success. This postures Velocity Management well to support an MTW.

The research leads to a conclusion that Velocity Management will support an MTW. The current transportation shortages would present some problems for any logistics system, but the research indicates that Velocity Management is best suited to provide a dynamic solution to this problem.

APPENDIX A

GLOSSARY

U.S. Army Materiel Command (AMC). The Army's principal materiel developer. AMC works closely with industry, colleges and universities, sister services, and other government agencies to provide acquisition excellence, logistics power projection, and technology generation and application competencies. It consists of eleven (11) major subordinate commands (MSC) that direct the activities of numerous depots, arsenals, ammunition plants, laboratories, test activities, and procurement operations (FM 100-10).

Authorized Stockage List (ASL). A list of items from all classes of supply authorized to be stocked at a specific echelon of supply (FM 101-5-1).

Combat Load. Those quantities of all classes of supplies kept by a unit to sustain operation in combat for a prescribed number of days. Combat loads must be capable of being moved into combat in one lift using organic transportation (FM 10-1).

Communications Zone (COMMZ). Rear part of theater of operations which contains the lines of communications, establishments for supply and evacuation, and other agencies required for the immediate support and maintenance of the field forces (JP 1-02).

Corps Support Command (COSCOM). Supports all corps forces and, when directed, other forces and civilians. The COSCOM is organized to meet the needs of the situation and does not have one fixed structure to modify. It includes a headquarters, materiel management center (MMC), movement control center (MCC), corps support groups (CSGs), medical brigade, and (if required) transportation group (FM 100-10).

Combat Service Support (CSS). The essential capabilities, functions, activities, and tasks necessary to sustain all elements of operating forces in theater at all levels of war. It includes, but is not limited to that support rendered by service forces in ensuring the aspects of supply, maintenance, transportation, health services and other services required by combat troops to permit those units to accomplish their missions in combat. CSS encompasses those activities at all levels of war that produce sustainment of all operating forces on the battlefield (FM 100-10).

Digitization. The insertion of digital technologies across all levels and within both combat and support organizations on the battlefield. The advantages of digitization include enhanced command and control (including CSS) resulting from a common picture of the battlefield, improved situational awareness, better compatibility across battlefield operating systems, and shorter decision cycles (FM 100-10).

Division Support Command (DISCOM). Provides division-level logistics to all organic and attached elements of the division. All DISCOMs consist of a headquarters and materiel management center (MMC), forward support battalions (FSBs), a main support battalion (MSB), and an aviation support battalion (ASB) or aviation intermediate maintenance (AVIM) organization (FM 100-10).

Distribution System. The complex of facilities, installations, methods, and procedures designed to receive, store, maintain, move, and control the flow of materiel, personnel, and services between the point of receipt into the military system and the point of provision to using activities and units. The distribution system is a major focus of JIT principles (FM 100-10).

Forward Logistics Element (FLE). A multifunctional forward logistics element task-organized to support fast-moving offensive operations, early phases of contingency operations, and units geographically separated from normal support channels. The FLE operates out of a forward logistics base (FM 101-5-1).

Host-Nation Support. Civil and /or military assistance rendered by a nation to foreign forces within its territory during peacetime, crises or emergencies, or war based on agreements mutually concluded between nations (FM 101-5-1).

In-Transit Visibility (ITV). The capability to identify the location of resources at any moment in the distribution pipeline (FM 101-5-1).

Inventory Management. A combination of six functions; requirements determination, catalog direction, procurement direction, distribution direction, maintenance (repair) direction, and reutilization/disposal direction.

Just In Time (JIT). Refers to management principles developed by Dr. W. Edwards Deming and employed by many Japanese and U.S. industries. This principle advocates decreasing on-hand inventory levels by using efficient systems to ensure the right resource, in the necessary quantity, is provided at the right time.

Logistics Civil Augmentation Program (LOGCAP). A capstone program consisting of several types of contracting capabilities that support contingency operations. It includes all preplanned logistics and engineering/construction-oriented contingency contracts actually awarded and peacetime contracts that include contingency clauses (FM 100-10).

Logistics. The science of planning and carrying out the movement and maintenance of forces. Those aspects of military operations which deal with: a) design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel; b) movement, evacuation, and hospitalization of personnel; c) acquisition or construction, maintenance, operation, and disposition of facilities; and d) acquisition or furnishing of services (JP 1-02).

Logistics Preparation of the Theater (LPT). This process includes all the actions taken by CSS personnel to maximize the means of supporting the commander's plan. LPT involves two closely related activities- information gathering and management, and activities required to prepare the theater to receive and sustain forces (FM 100-10).

Logistics Support Element (LSE). A flexible, civilian-oriented table of distribution and allowances (TDA) organization that provides limited general support (GS) and depot-level logistics. It will be rapidly deployable and its structure will evolve during the course of the operation to adapt to changing requirements and capabilities of deployed organizations. The LSE can shorten the pipeline by providing the same support in theater that AMC provides in CONUS (FM 100-10).

Order Ship Time (OST). The time elapsing between the initiation of stock replenishment action for a specific activity and the receipt by that activity of the materiel resulting from such action. Order and shipping time is applicable only to materiel within the supply system, and it is composed of the distinct elements, order time, and shipping time (JP 1-02).

Total Asset Visibility (TAV). The capability to provide timely and accurate information on the identity, status, and location of DOD materiel from the source of production to delivery to the user and ultimate disposal (FM 100-10).

Velocity Management (VM). The Army's adopted JIT model. A program designed to replace mass with speed and accuracy in the Army logistics system, it incorporates the personnel, metrics, information systems, and C2 to support the Army (CASCOM Web Site).

APPENDIX B

ECCLES' LOGISTICS THEMES

1. Modern war covers an entire spectrum of human conflict.
2. Strategy should be considered as the comprehensive direction of power for the purpose of exercising control of a field of action in order to attain objectives.
3. Logistics is the bridge between our national economy and the actual operations of our combat forces in the field.
4. Unless restrained by wise, adequate, and timely planning, logistic installations and operations tend to snowball out of all proportion to the true needs of combat support.
5. Sound logistics forms the foundation for the development of strategic flexibility and mobility. If such flexibility is to be exercised and exploited, military command must have adequate control of its logistic support.
6. The understanding of the nature and degree of logistic control which command should exercise is essential to the attainment of combat effectiveness (Eccles 1959, 10).

APPENDIX C

HEISER'S LOGISTICS IMPERATIVES

1. Involve the commander in all aspects of logistics.

Commanders must ensure that economy of logistics force is the basic principle of their commands. The major objective of economy of logistics force is getting materiel and services from the source of support to the troops in the right quantity, in the right condition, and at the right time in order to gain combat effectiveness.

2. Prioritize logistics requirements.

3. Ensure logistics support is consistent with requirements.

Discipline in establishing requirements ensures the optimum economy of the logistic support force to meet combat readiness and effectiveness.

4. Train logisticians under wartime conditions.

5. Organize logistics systems in peacetime so they will function in war.

Logistics processes such as the direct exchange of modules, closed loop controls, and inventory-in-motion systems should be in place to assure prompt support of critical items.

6. Incorporate commodity and functional capabilities into all echelons of logistic support.

7. Consider logistics constraints in establishing operational capabilities.

8. Determine requirements based on factual data.

Logistics data used to establish requirements must be suitable for both manual and automated operations. Communications methods and automatic data processes at all levels must be optimized to achieve a paperless SOP to enhance responsive logistic support with minimum user tasks, but they must all be prepared for manual operations in case of power failure.

9. Be flexible in adapting capabilities to requirements.

In Hannibal's time, supply by elephants represented "state of the art" logistics, a state replaced in our times by modern communications, automation, transportation, and intelligence. Commanders today must rely for the most part on a zone of interior-based supply inventory in motion and on an echeloned maintenance support system. Insurance items must be retained at the ready in rear echelons, usually in CONUS. Depot stocks of all supplies, except Class III and Class V, should be normally restricted to CONUS and inventory-in-motion principles applied to all supplies.

10. Learn from history for "the past is prologue."

Time and environment change, but basic logistics problems and human nature remain the same. Our learning and implementing lessons from the past will defeat the opposition (Heiser 1991, 260-264).

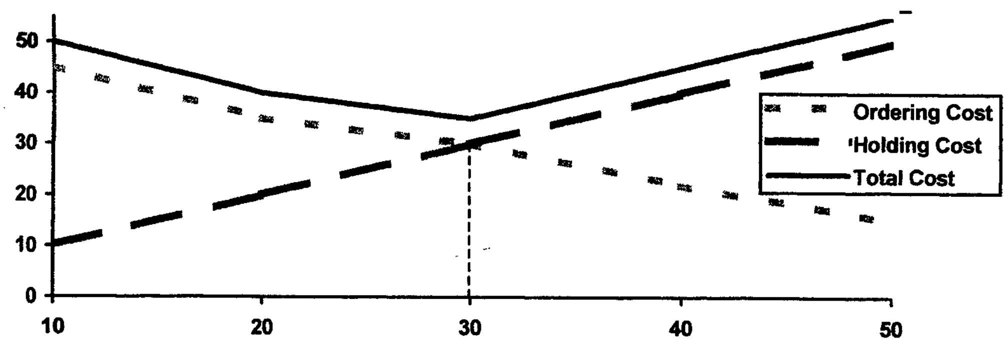
APPENDIX D

REQUIREMENTS DETERMINATION PROCESSES

Requirements Determination using Economic Order Quantity (EOQ):

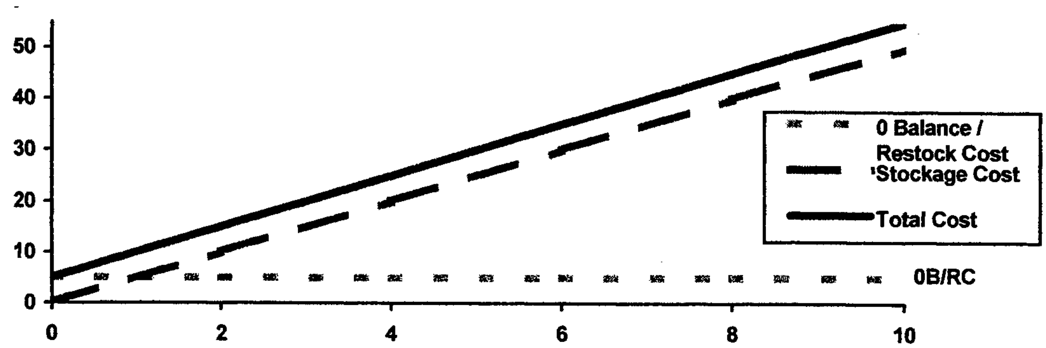
$$EOQ = \sqrt{\frac{2CY}{HU}}$$

where: Y = the yearly demands
C = the cost to place an order
H = the cost to hold an item
U = unit costs



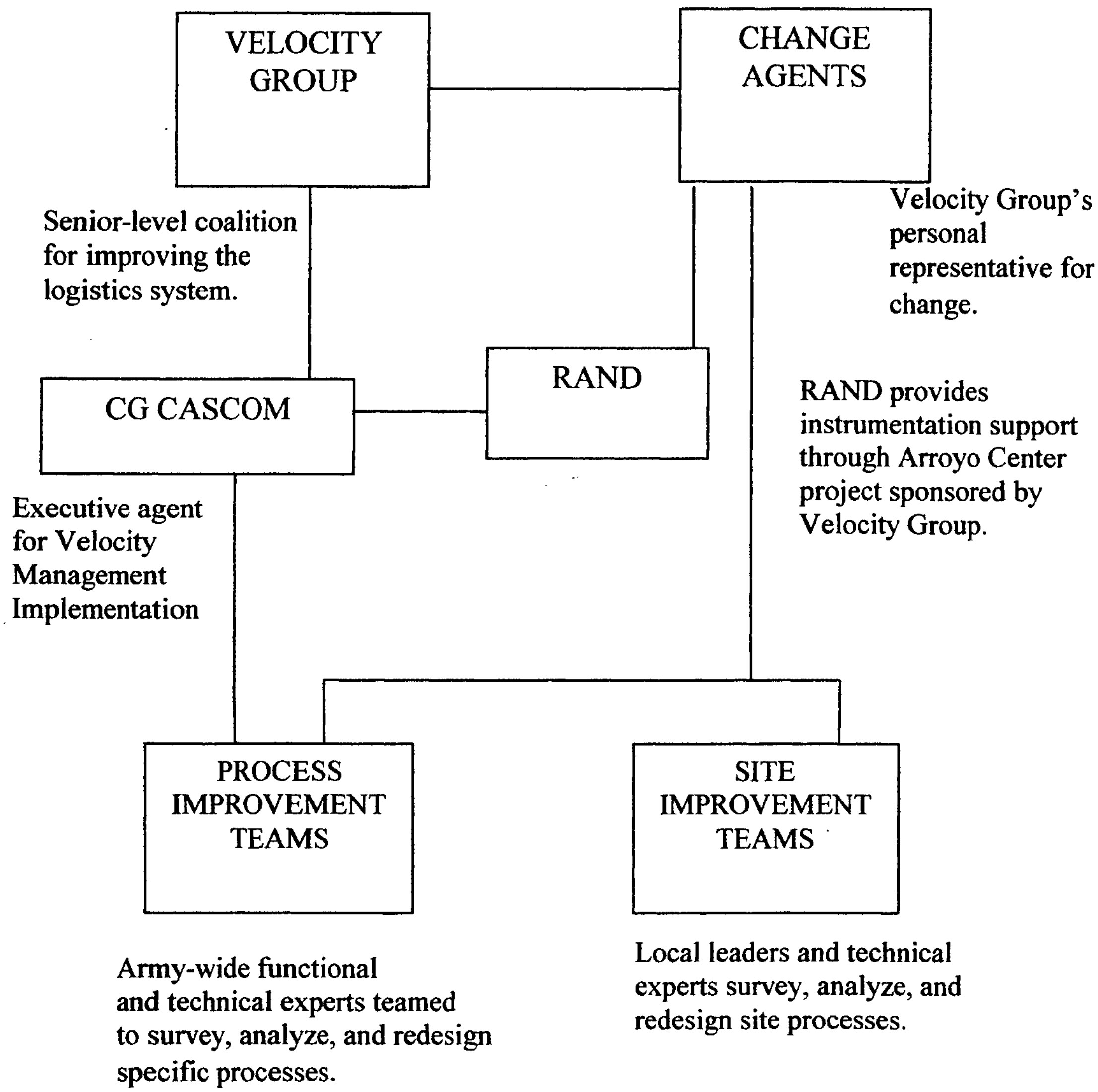
Requirements Determination using Just-In-Time (JIT) Concept:

TC = SC + 0B/RC



APPENDIX E

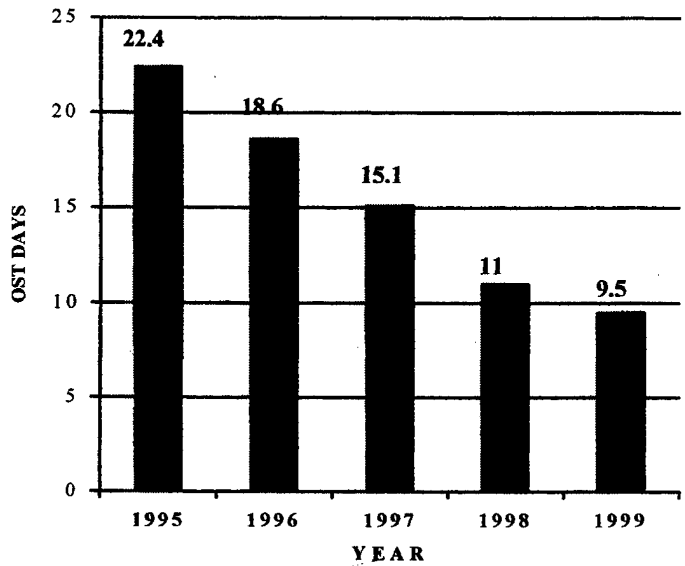
VELOCITY MANAGEMENT ORGANIZATION DIAGRAM



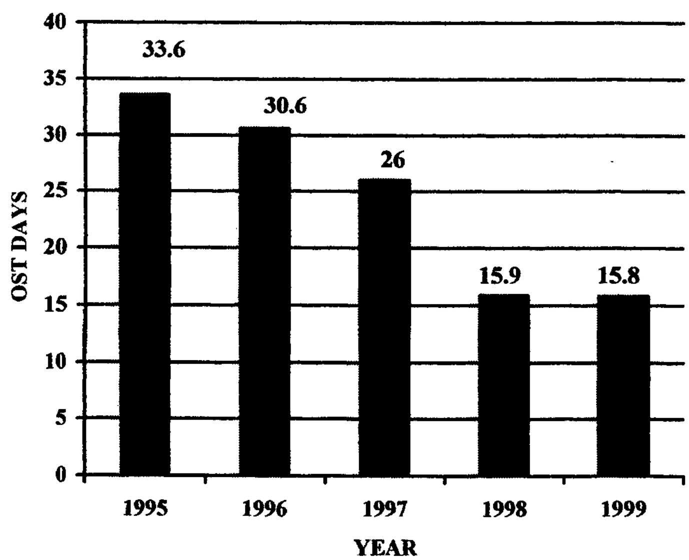
APPENDIX F

ORDER SHIP TIME PROGRESS

CONUS OVERALL REDUCTION
1995-1999

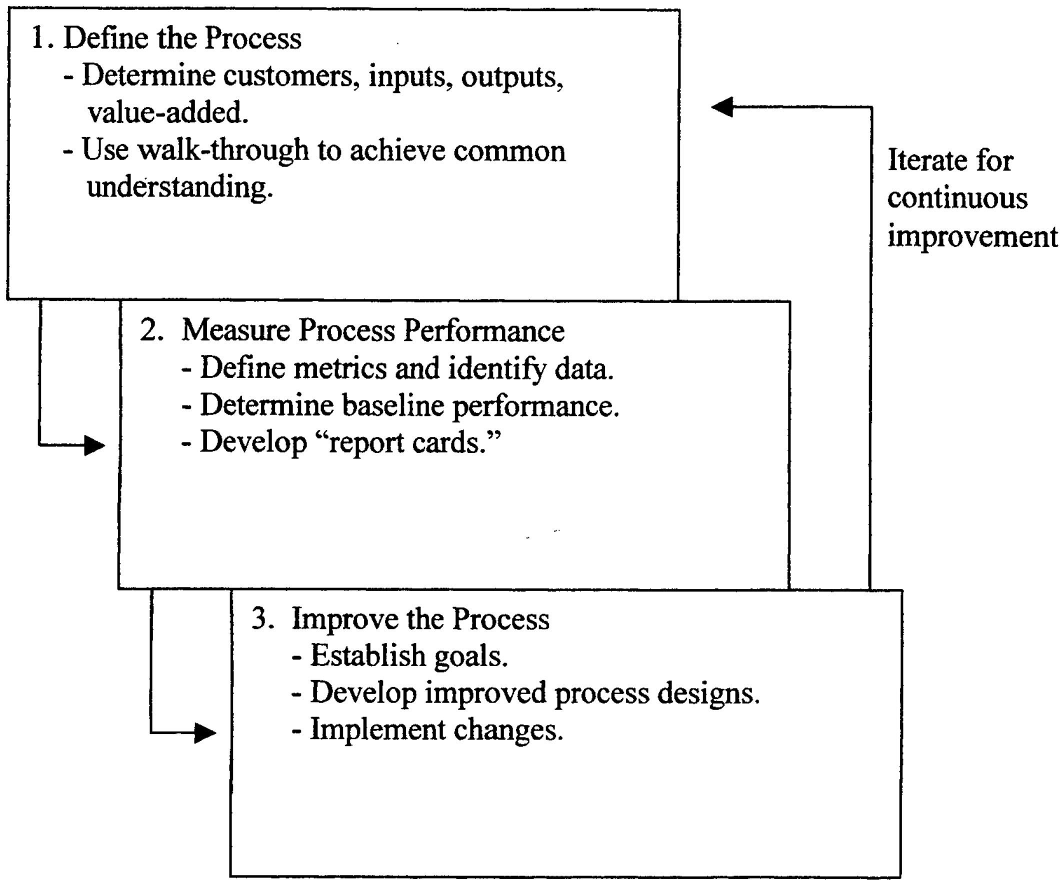


OCONUS OVERALL REDUCTION
1995-1999



APPENDIX G

VELOCITY MANAGEMENT METHODOLOGY



REFERENCES

Barfield, Jesse T., Cecily A. Raiborn, and Michael R. Kinney. 1994. *Cost Accounting: Traditions and Innovations.* Minnesota: West Publishing Company.

Berman, Morton B., Douglas W. McIver, Marc W. Robbins, and John F. Schank. 1988. *Evaluating the Combat Payoff of Alternative Logistics Structures for High-Technology Subsystems.* Santa Monica, CA: The RAND Corporation.

Blackwell, James. 1991. *Thunder in the Desert: The Strategy and Tactics of the Persian Gulf War.* New York, NY: Bantam Books.

Blount International. 2000. *Company History Homepage.* Available from http://www.blount.com. Internet. Accessed 1 May 2000.

CASCOM. 2000a. *Velocity Management Army National Guard PIT Mission Statement.* Available from http://www.cascom.lee.army.mil/vm/ARNG.htm. Internet. Accessed 2 May 2000.

________. 2000b. *Velocity Management Deployed Operations PIT Mission Statement.* Available from http://www.cascom.lee.army.mil/vm/DO.htm. Internet. Accessed 2 May 2000.

________. 2000c. *Velocity Management Financial Management PIT Mission Statement.* Available from http://www.cascom.lee.army.mil/vm/fin.htm. Internet. Accessed 2 May 2000.

________. 2000d. *Velocity Management Order Ship PIT Mission Statement.* Available from http://www.cascom.lee.army.mil/vm/ost.htm. Internet. Accessed 2 May 2000.

________. 2000e. *Velocity Management Repair Cycle PIT Mission Statement.* Available from http://www.cascom.lee.army.mil/vm/rc.htm. Internet. Accessed 2 May 2000.

________. 2000f. *Velocity Management Stockage Determination PIT Mission Statement.* Available from http://www.cascom.lee.army.mil/vm/sd.htm. Internet. Accessed 2 May 2000.

________. 2000g. *Velocity Management Transportation PIT Mission Statement.* Available from http://www.cascom.lee.army.mil/vm/trans.htm. Internet. Accessed 2 May 2000.

________. 2000h. *Velocity Management United States Army Reserve PIT Mission Statement.* Available from http://www.cascom.lee.army.mil/vm/USAR.htm. Internet. Accessed 2 May 2000.

________. 2000i. *Velocity Management:The Strategy to Re-Engineer the Army's Logistics Process.* Briefing on-line. Available from http://www.cascom.lee.army.mil/vm/Online_Briefing/sld002.htm. Internet. Accessed 27 March 2000.

Drummand, John, Rick Eden, and John Folkeson. 1994. *Weapon System Sustainment Management: A Concept for Revolutionizing the Army Logistics System.* Santa Monica, CA; The RAND Corporation.

________. 1995. *The Velocity Management Initiative:Implementing an Approach for Improving the Effectiveness and Efficiency of Army Logistics Processes.* Executive briefing presented to Vice Chief of Staff of the Army, Washington, D.C.: The RAND Corporation.

Eccles, Henry E. 1959. *Logistics in the National Defense.* Harrisburg, PA: Stackpole Press.

Engles, Donald W. 1978. *Alexander the Great and the Logistics of the Macedonian Army.* Berkeley: University of California Press.

Heiser, Joseph M. 1991. *A Soldier Supporting Soldiers.* Washington, DC: Center of Military History, Department of the Army.

Hinton, Donald H. 1995. "A Customers Perspective on Army Material Distribution," *Army Logistician,* January-February, 8-11.

House, Jonathon M. 1984. *Toward Combined Arms Warfare: A Survey of 20th Century Tactics, Doctrine, and Organizations.* Ft. Leavenworth, KS: CGSC.

Huston, James A. 1988. *The Sinews of War: Army Logistics, 1775-1953.* Washington, DC: Center of Military History, Department of the Army.

Kelly, Kevin. 1993. "The Rumble Heard Around the World – Harleys," *Business Week,* Industry/Technology Edition, 24 May, 58.

Klima, Gerald G., Jr. 1993. "Just-in-time; Mission Accomplished," *Army Logistician,* March-April, 28-29.

Magruder, Carter B. 1988. *Recurring Logistics Problems as I Have Observed Them.* Washington, DC: Center of Military History, Department of the Army.

McGee. Michael L. 1994. "Just -in Time or Just too Late," *Army Logistician,* March-April, 15-17.

Ohl, John K. 1994. *Supplying the Troops: General Somervell and American Logistics in WWII.* Illinois: Northern Illinois University Press.

Pagonis, William G. 1992. *Moving Mountains.* Boston: Harvard Business School Press.

Pagonis, William G., and Harold E. Raugh. 1991. "Good Logistics is Combat Power," *Military Review,* September, 28-39.

Peppers, Jerome G. 1988. *History of United States Military Logistics: 1935 - 1985.* Huntsville, AL: Logistics Education Foundation Publishing.

Plumley, Wilfred J., Jr. 1994. *Just-In-Time Inventory Management: The Feasibility of Implementation at Watervliet Arsenal's Directorate of Public Works.* Fort Lee, VA: Florida Institute of Technology.

Reichert, Thomas A. 1994. "Commentary-JIT: Tell it like it is," *Army Logistician,* November-December, 33.

Reid, Peter C. 1990. *Well Made in America; Lessons From Harley-Davidson on Being the Best.* New York: McGraw-Hill Publishing Company.

Rosen, Stephen. 1994. *Winning the next War: Innovation and the Modern Military.* Ithaca NY: Cornell Press.

Rutenberg, David C., and Jane S. Allen. 1983. *The Logistics of Waging War.* Gunter Air Force Station, AL.: Air Force Management Center.

Sandia National Laboratories. 2000. *History and Mission of Sandia.* Available from http://www.sandia.gov/history.html. Internet. Accessed 1 May 2000.

Schoneberger, Richard J. 1982. *Japanese Manufacturing Techniques.* New York, Macmillan Publishing Company.

Schwarzkopf, Norman. 1992. *It Doesn't Take a Hero.* New York: Bantam Books.

Shaw, George C. 1938. *Supply in Modern War.* London: Faber & Faber.

Shrader, Charles R. 1997. *United States Army Logistics, 1775-1992: An Anthology.* Washington, DC: Center of Military History, Department of the Army.

Taylor, Paula Y. 1992. *A Study to Determine the Feasibility of Adopting the Just-In-Time Inventory Concept at the Army's Class IX Retail Supply System.* Fort Lee, VA: Florida Institute of Technology.

Tuttle, Gen. (Ret) William Jr. 1991. "Sustaining Army Forces - Part II," *Army Logistician,* November- December, 8-15.

U.S. Department of the Army. 1990a. FM 63-3: *Corps Support Command.* Washington, DC: Headquarters, Department of the Army.

________. 1990b. FM 63-21: *Main Support Battalion.* Washington, DC: Headquarters, Department of the Army.

________. 1993a. FM 63-2: *Division Support Command, Armored, Infantry and Mechanized Infantry Divisions.* Washington, DC: Headquarters, Department of the Army.

________. 1993b. FM 100-5: *Operations.* Washington, DC: Headquarters, Department of the Army.

________. 1995. FM 100-10: *Combat Service Support.* Washington, DC: Headquarters, Department of the Army.

________. 1996. FM 100-15: *Corps Operations.* Washington, DC: Headquarters, Department of the Army.

________. 2000. *Army Posture Statement FY00.* Available from http://www.army.mil/aps/00/aps00.htm#page43. Internet. Accessed 2 May 2000.

VanAirsdale, Michael J. 1992. "Just-in-Time Inventory: Trading Efficiency for Effectiveness," *Army Logistician,* March-April, 8-10.

Van Creveld, Martin. 1977. *Supplying War: Logistics from Wallenstein to Patton.* New York: Cambridge University Press.

INITIAL DISTRIBUTION LIST

Combined Arms Research Library
U.S. Army Command and General Staff College
1 Reynolds Ave.
Fort Leavenworth, KS 66027-1352

Defense Technical Information Center
Cameron Station
Alexandria, VA 22314

LTC Willis F. Jackson, Jr.
Department of Logistics and Resource Operations
USACGSC
1 Reynolds Ave.
Fort Leavenworth, KS 66027-1352

LTC Lewis L. O'Hern
CAS3
USACGSC
1 Reynolds Ave.
Fort Leavenworth, KS 66027-1352

Dr. James B. Martin
Baker University
6600 College Blvd.
Suite 340
Overland Park, KS 66211

CERTIFICATION FOR MMAS DISTRIBUTION STATEMENT

1. Certification Date: 2 June 2000

2. Thesis Author: Major William B. Miracle

3. Thesis Title: Just-in-Time Effects on Peacetime Efficiency and Wartime Readiness

4. Thesis Committee Members

   Signatures: Lewis Rankin Olker, JR.

5. Distribution Statement: See distribution statements A-X on reverse, then circle appropriate distribution statement letter code below:

A B C D E F X   SEE EXPLANATION OF CODES ON REVERSE

If your thesis does not fit into any of the above categories or is classified, you must coordinate with the classified section at CARL.

6. Justification: Justification is required for any distribution other than described in Distribution Statement A. All or part of a thesis may justify distribution limitation. See limitation justification statements 1-10 on reverse, then list, below, the statement(s) that applies (apply) to your thesis and corresponding chapters/sections and pages. Follow sample format shown below:

EXAMPLE

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
Direct Military Support (10)	/	Chapter 3	/	12
Critical Technology (3)	/	Section 4	/	31
Administrative Operational Use (7)	/	Chapter 2	/	13-32

Fill in limitation justification for your thesis below:

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
	/		/	
	/		/	
	/		/	
	/		/	
	/		/	

7. MMAS Thesis Author's Signature: William B Miracle

STATEMENT A: Approved for public release; distribution is unlimited. (Documents with this statement may be made available or sold to the general public and foreign nationals).

STATEMENT B: Distribution authorized to U.S. Government agencies only (insert reason and date ON REVERSE OF THIS FORM). Currently used reasons for imposing this statement include the following:

1. Foreign Government Information. Protection of foreign information.

2. Proprietary Information. Protection of proprietary information not owned by the U.S. Government.

3. Critical Technology. Protection and control of critical technology including technical data with potential military application.

4. Test and Evaluation. Protection of test and evaluation of commercial production or military hardware.

5. Contractor Performance Evaluation. Protection of information involving contractor performance evaluation.

6. Premature Dissemination. Protection of information involving systems or hardware from premature dissemination.

7. Administrative/Operational Use. Protection of information restricted to official use or for administrative or operational purposes.

8. Software Documentation. Protection of software documentation - release only in accordance with the provisions of DoD Instruction 7930.2.

9. Specific Authority. Protection of information required by a specific authority.

10. Direct Military Support. To protect export-controlled technical data of such military significance that release for purposes other than direct support of DoD-approved activities may jeopardize a U.S. military advantage.

STATEMENT C: Distribution authorized to U.S. Government agencies and their contractors: (REASON AND DATE). Currently most used reasons are 1, 3, 7, 8, and 9 above.

STATEMENT D: Distribution authorized to DoD and U.S. DoD contractors only; (REASON AND DATE). Currently most reasons are 1, 3, 7, 8, and 9 above.

STATEMENT E: Distribution authorized to DoD only; (REASON AND DATE). Currently most used reasons are 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10.

STATEMENT F: Further dissemination only as directed by (controlling DoD office and date), or higher DoD authority. Used when the DoD originator determines that information is subject to special dissemination limitation specified by paragraph 4-505, DoD 5200.1-R.

STATEMENT X: Distribution authorized to U.S. Government agencies and private individuals of enterprises eligible to obtain export-controlled technical data in accordance with DoD Directive 5230.25; (date). Controlling DoD office is (insert).